International Science Collaboration on GPM Ground Validation

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Outline

I. Brief Summary of U.S. GV Science status
- Most recent U.S. GV Science panel white paper
- Two recent efforts:
  - Current winter field campaign prototype: C3VP
  - Discussion with/scheduled visit to FMI (Helsinki Testbed)

III. Topics for discussion
- Strategies, synergies and priorities
  - Low hanging fruit!

Sept., 2006, GV Science Panel White Paper: Ground Validation Strategy

I. Cross Cutting Themes:

1. Uncertainty estimation
2. Algorithm improvement
3. Integration of data sources

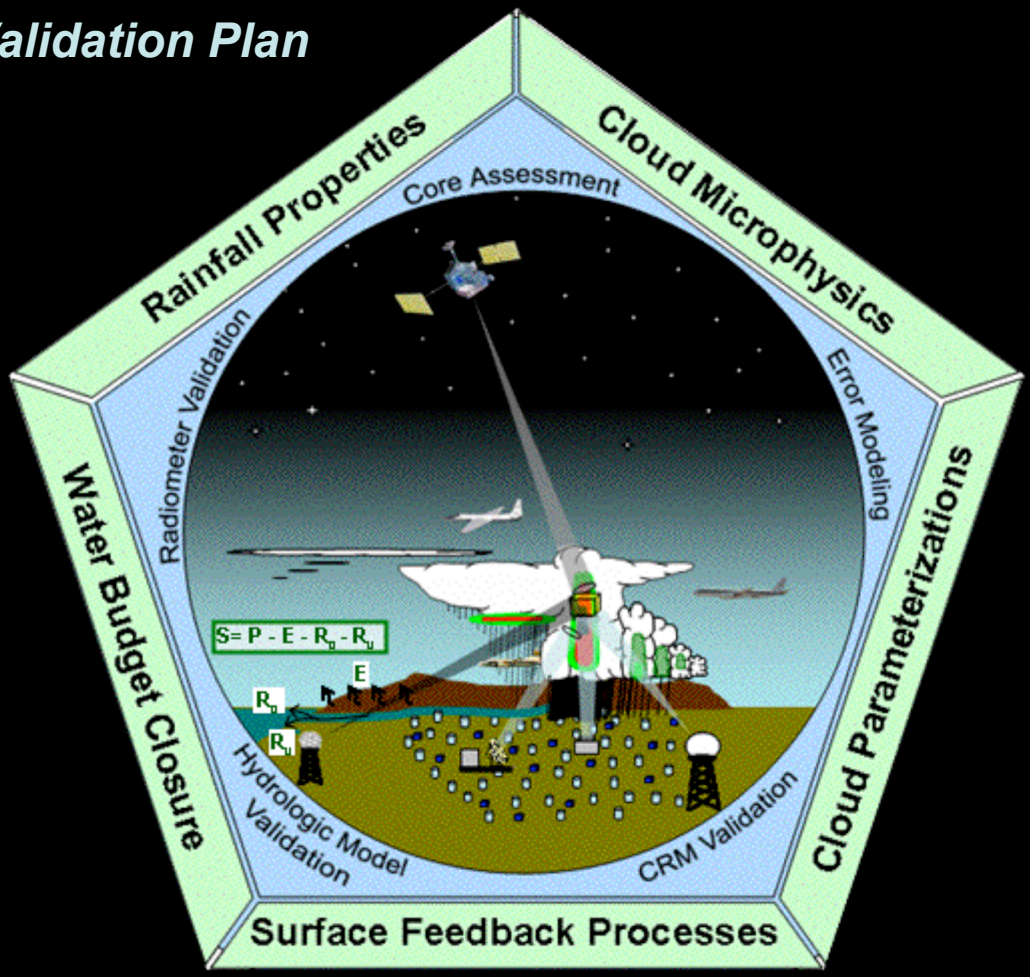
II. GV Strategy: Direct, Process, and integrated validation encapsulated into five broad objectives:

1. **Core satellite error characterization**: ***National networks for direct validation*** and uncertainty estimation of targeted parameters (e.g., Z, PIA, D_0, rain rate). ***Process-site studies to establish physical linkages*** between uncertainties.
2. **Constellation satellite validation**: National network for direct validation but largest ***emphasis on improved physics in radiometer algorithms***. Airborne/ground-based microphysics observations integrated with coupled land surface/atmosphere models.
3. **Physical model development** (propagating uncertainty)
   - Snow- establish capabilities of HF radiometers using snowfall datasets to develop particle and bulk layer radiative properties for testing/modification of algorithms.
   - Cloud water- determination of cloud and rainwater amounts and 3-D distribution within radiometer and DPR footprints. Specifies need for airborne sampling.
   - Mixed phase- specification of particle geometry, density, and melt water fractions. Combined airborne and ground based sampling needed.
4. **Cloud-Resolving Models:** Provide physical and space/time bridging to observations/algorithms; form backbone of several latent heating algorithms. Require detailed ground and airborne cloud process measurements, and forcing datasets.

5. **Coupled modeling and closure of the water budget:** Cross-cutting, end-to-end, integrated activity linking surface water budgets, ground emissivity, precipitation variability and microphysics, to radiative transfer algorithms and associated retrievals. Requires infrastructure noted for all other objectives in addition to land surface vegetation and soil characteristics, water and energy budget terms.

- **Path exploits numerous synergies and approaches**

Integrated Validation Plan



Participation in the Canadian CloudSat/Calipso Validation Program (C3VP)

Winter 2006-2007

Purposes:

1. ***Contribution to CloudSAT/CALIPSO validation,***
2. ***Collection of data sets for development of GPM snowfall detection and estimation algorithms***

- *To **develop models** that convert **microphysical properties** (snow size, shape distributions, density, ice-air-water ratio) **to radiative properties** (asymmetry factor, absorption-scattering-backscatter coefficients)*
- *To **relate radiative properties to microwave radiances and radar reflectivities** observed by GPM instruments*
- *To combine satellite, aircraft and ground measurements for GPM **GMI and DPR algorithm validation***
- *To **support Cloud-Resolving Model (CRM)** microphysics validation in cold-region simulations*

3. ***Further support ongoing EarthCARE-GPM satellite simulator algorithm collaboration***

- *Development of f**ully coupled, physically-based modeling system** including land-surface, atmosphere, precipitation and radiative transfer simulations/interactions*

Physical Validation, Snow: *Winter 2006-07 Field Campaign*
Canadian CloudSat/Calipso Validation Project (C3VP)

Collaboration: Canadian MSC/EC, NASA-JPL CloudSat, NASA-Glenn, McGill U., PSU, and CSU-CIRA DoD Geosciences Center (CLEX-10)

EC Centre for Atmospheric Research Experiments (CARE) site located ~70km north of Toronto

Instrument array including multi-freq. radars, disdrometers, gauges, radiometers, lidars, and radiosonde

King City dual-Pol C-Band Radar ~30km from CARE (10 minute scan cycle); High resolution RHI's to be run over CARE

Four aircraft IOPs:

IOP-1: October 31 - November 9
IOP-2: November 30 - December 11
IOP-3: January 17 - January 28 NASA PMM/GPM
IOP-4: February 18 - March 1

IOPs include C580 aircraft carrying extensive microphysical instrumentation. Regional Modeling System output (EC and CSU-RAMS) during entire field campaign.

Ground Instrumentation at CARE

Affliation	Sensor / system	Measurement
NASA/JPL	W-band Polarimetric radar	Cloud phase, particle type, precip rate
UMass	Adv Multi-Freq Radar (W, Ka, Ku-band)	Cloud phase, particle type, precip rate
EC	Ceilometer	Geometric cloud profile
McGill	X-band VertiX Doppler radar	Cloud detection, particle type
McGill	Video Disdrometer	Precip fall velocity and shape, DSD
CSU	2D video disdrometer	Precip fall velocity and shape, DSD
NASA/GSFC	Parsivel optical disdrometer	Precip rate, precip type, DSD
EC	POSS	Precip rate, precip type, DSD
EC	HotPlate	Precip rate
EC	Geonor precipitation gauge	Precip rate
EC	Visibility meter	Visibility, present weather indicator
EC	10m met tower	P, T, RH, wind
EC	TP/WVP-3000 profiling radiometer	LWP
NASA/GRC	89 & 150 GHz profiling radiometer	LWP w/ sensitivity to ice particles
EC	915MHz wind profiler w/ RASS	Wind profile, turbulence, temp profile
EC	Vaisala radiosonde system	P, T, RH, wind profiles
EC	Broadband radiometers	Pyranometer & pyrgeometer
PennState	Dual-radiometer package	Cloud optical depth
McGill	Ground particle photography	Particle imaging & sample collection

Convair aircraft instrumentation

Full range of particle sizes

Cloud Spectrometers (under wing pylons)

- PMS PCASP-100X probe (0.1-3.0 μm)
- PMS FSSP-300X probe (0.3-20 μm)
- **2 PMS FSSP probes** (2-47 μm, 5-95 μm)
- **PMS 2D2-C probe** (25-800 μm)
- **SPEC 2D-S probe** (10-1280 μm)
- PMS 2DC-grey probe (15-960 μm)
- DMT CIP probe (12- 768 μm)
- **PMS 2D-P probe** (200-6400 μm)
- **SPEC HVPS probe** (200-25000 μm)

Other Instrumentation

- AERIAL (AERosol Imaging Airborne Lidar)
- Ka band radar (non-polarimetric, non-doppler)
- NRC X-band/W-band polarimetric radar
- Broadband Visible and Infrafred Radiometers
- Extinction probe
- Ice Nucleus Counter (CSU)
- Rosemount Ice detector
- TAMDAR (winds, turbulence, temperature, relative humidity, icing)

Boreal Winter/Maritime Validation

Helsinki Testbed (FMI)

Exploring long term collaboration and synergies with FMI for N. Latitude snowfall/land surface (e.g., snow pack, soil moisture etc.) measurement using resources available to Helsinki Testbed.

Moist/wet, cold marine climate 60-65 N (400-700 mm annual precipitation)

Extensive instrumentation (Dual-polarimetric and conventional C-band radars, potential Ka/Ku pair, profilers, snow gauges, mesonet etc.) and **long term operations**

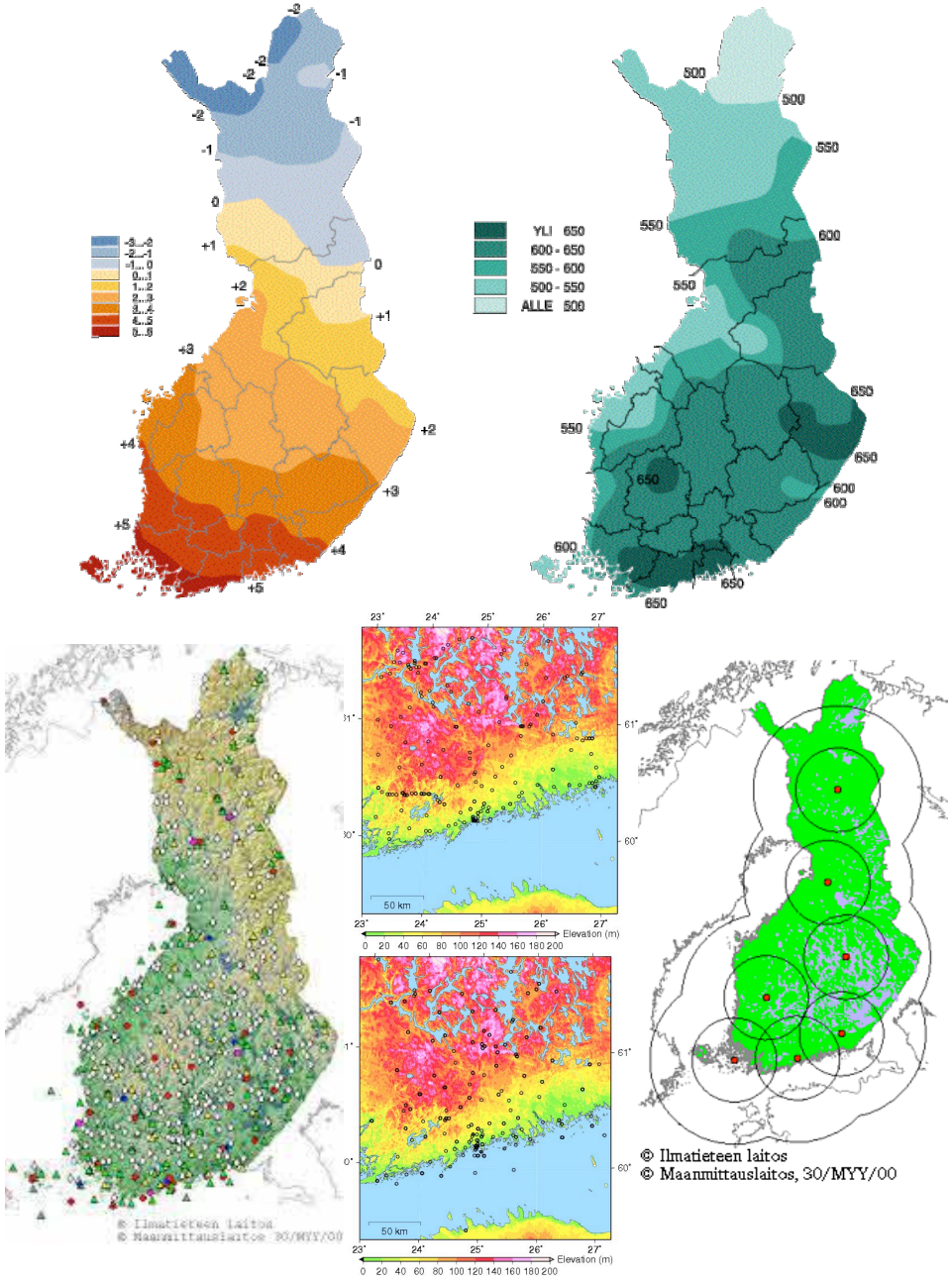
Web-based data interface and an open dataset policy

Extensive land surface and vegetation mapping

Experience in snowfall measurement and coupled modeling

Participant in CloudSat GV

Discussion of Synergies/Strategy underway (GPM team to Helsinki Feb. 2007).



Discussion:

- *Partners*: Australia, Brazil, Canada, China, EU, India, Japan, South Africa, South Korea, Taiwan, United States…….others?

Questions/Topics:

- *Strategies:* What strategies are other countries pursuing and how consistent are the strategies? *Direct vs. Physical validation and priority efforts*
- *Synergies:* E.g., NASA GPM SSM and EC EarthCARE Simulator collaboration….similar goals- algorithm/methods sharing). IPWG? CloudSat? IPWG?
- *Gap Filling:* Complimentary GV activities that fill important gaps in regime sampling or methodology? (e.g., cold season, light precipitation regimes, oceanic, orographic……..etc.).

Potential low-hanging fruit?

- *Bilateral national network operations for direct validation*: Much already being done. Identify common/standar procedures and methods? Export/coordinate methods/algorithms?
- *Physical validation-* Obvious problems- radiometer algorithms over land; snow/light precipitation? Orographic precip. Start early w/coordinated efforts?
- *Data* access and distribution. Does an international "GPM GV web portal" for distributed data access and results make sense?